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(54) A suturing instrument for use in arthroscopic surgery.

(57) A suturing instrument (20) for use in arthroscopic surgery includes a hollow needle (56) for penetrating tissue to be sutured within the body while the tissue is clamped between relatively movable jaws (34, 44), and a suture feed mechanism (68) for feeding suture material (90) through the hollow needle such that the jaws (34,44) can be opened and the suturing instrument withdrawn from the body pulling the free end segment of the suture material (90) with the instrument. A knot can be tied in the suture material (90) externally of the body and the knot moved back into the body at a position adjacent the tissue.

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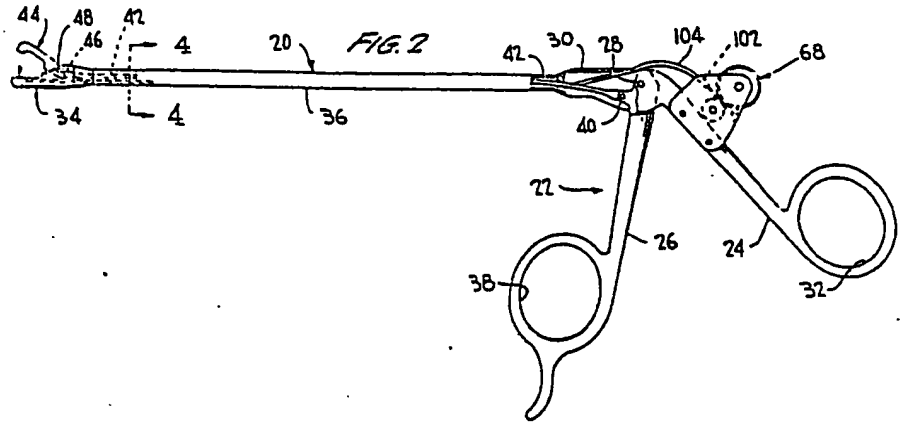


FIG. 2

A SUTURING INSTRUMENT FOR USE IN ARTHROSCOPIC SURGERY

This invention pertains to a suturing instrument for use in arthroscopic surgery, such as, for example, for arthroscopic suturing of tissue within the body without requiring open surgery.

Arthroscopic surgery, which is used herein to encompass surgery on various parts of the body requiring only small incisions or portals for insertion of diagnostic and surgical instruments manipulated externally of the body as well as such surgery performed on joints, is preferable over open surgery to avoid the trauma associated with large incisions as well as the hospitalization and prolonged recovery periods required with open surgery and is used whenever possible to achieve the same results as open surgery without the disadvantages thereof. Arthroscopic techniques include internal viewing for diagnosis and identification of problems as well as surgical operations such as meniscus removal or repair, shaving of irregular, roughened patella and other surfaces and articular surface smoothing. While many surgical operations that previously required open surgery can now be performed by arthroscopic surgery, there remain operations that still require open surgery due to the need for direct suturing, such as major ligament repair and cartilage repair.

U. S. Patents No. 4,493,323 to Albright et al, and Nos. 4,602,635 and 4,621,640 to Mulhollan et al are representative of prior art instruments for internal suturing without requiring open surgery; however, such instruments have the disadvantages of requiring multiple instrument manipulation and movement of needles carrying sutures entirely through tissue to be sutured. The instrument of the Albright et al patent includes a pair of needles forced outwardly through the end of a tube by a plunger to penetrate and extend through the tissue to be sutured and through the skin to permit the needles to be grasped by the surgeon and pulled to position a suture thread loop attached to the needles. The instrument of the Mulhollan et al patent 4,621,640 includes a curved needle carried by a pivotal head movable to cause the needle to be set in the tissue to be sutured, the needle then being realised and the instrument withdrawn to allow insertion of another instrument to pull the needle through. The Mulhollan et al patent, 4,602,635 relates to an instrument for tying knots in sutures in a manipulation area external of the body after the sutures are sewn through the tissue and then pushing the knots into place adjacent the tissue.

U.S. Patents No. 919,138 to Drake et al, No. 3,840,017 to Violante, No. 4,224,947 to Fukuda, and No. 4,643,178 to Nastari et al are representative of prior art suturing instruments wherein sutures are passed through hollow needles after the needles penetrate through tissue to be sutured, such suturing instruments having the disadvantage of requiring grasping of the suture material and, thus, being useful only in open surgery and not in arthroscopic surgery.

U.S. Patents No. 1,815,725 to Pilling et al, No. 3,470,875 to Johnson, No. 3,842,840 to Schweizer, No, 3,946,740 to Bassett and No. 4,164,225 to Johnson et al are representative of prior art suturing instruments having pivoted, scissor-like arms with a needle forced through the end of one arm, through tissue to be sutured and into the end of the other arm where the suture is grasped or clamped, such suturing instruments having the disadvantage of being of a structural design to prevent their use in arthroscopic surgery.

U. S. Patent No. 4,312,337 to Donohue discloses an instrument for drilling and wiring bones having scissor-like arms carrying cannula sections through which a wire is passed, the wire being cut and tied after the cannula sections are withdrawn. The scissor-like structure permits this instrument to be used only in open surgery and not in arthroscopic surgery.

Another scissor-like instrument for suturing is disclosed in U. S. Patent No, 4,596,249 to Freda et al, the instrument having a hook passing through tissue to engage a suture and pull it back through the tissue, the instrument not being useful in arthroscopic surgery due to its scissor-like structure.

There is thus a need for a generally improved suturing instrument for use in arthroscopic surgery.

According to one aspect of the present invention there is provided a suturing instrument for use in arthroscopic surgery characterised by including a stationary member including an elongated tube having a proximal end and a distel end and a stationary handle member extending from said proximal end of said tube and grippable by a user, a movable handle member mounted on said stationary member and grippable by a user so as to be movable towards and away from said stationary handle member, jaw means disposed at said distel end of said tube for clamping and penetrating tissue to be sutured including a first jaw having a hollow needle extending therefrom, a second jaw having an opening therein, and means mounting said first and second jaws to permit relative movement of said jaws towards and away from each other to define closed and open positions, respectively, said needle extending into said opening in said second jaw when said jaw means is in said

closed position, connector means connecting said movable handle member with said jaw means to cause relative movement of said first and second jaws as said movable handle member is moved towards and away from said stationary handle member, and suture material feeding means for feeding suture material along said tube to said needle and, with said jaw means in said closed position, through said needle and said opening in said second jaw whereby suture material can be passed through tissue to be sutured when said jaw means is in said closed position and, thereafter, when said jaw means is in said open position, the suture material can be drawn away from the tissue to be sutured.

For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a top view of a suturing instrument according to the present invention,

Figures 2 and 3 are side elevations of the suturing instrument of Figure 1 with jaws in open and closed positions, respectively,

Figure 4 is a sectional view taken along line 4-4 of Figure 2,

Figures 5 and 6 are broken side views of the jaws of the suturing instrument of Figures 1 to 4 in closed and open positions, respectively,

Figure 7 is an exploded view of a suture feed mechanism of a suturing instrument of Figures 1 to 6,

Figures 8, 9 and 10 are top views of right-hand, straight and left-hand jaw means for the suturing instrument of Figures 1 to 7, and

Figures 11, 12, 13, 14, 15 and 16 illustrate a method of use of the suturing instrument of the present invention.

A suturing instrument 20 according to the present invention is illustrated in Figs. 1, 2 and 3 and included a handle 22 formed of a stationary handle member 24 and a movable handle member 26 pivotally mounted to stationary handle member 24 on a pivot pin 28 secured in a hub 30. The stationary handle member 24 has a thumb ring 32 at one end and forms part of a stationary member including hub 30, a distal stationary jaw 34 and an elongate tube or barrel 36. The movable handle member 26 has a finger ring 38 at one end and extends through an opening in the bottom of the hub to be mounted on pivot pin 28. A flange 40 extends distally from movable handle member 26 and is pivotally attached to a connector rod 42 extending within tube 36 to the distal end thereof where the rod is connected to a pivotal jaw 44 via a pin 46, the jaw 44 being pivotally mounted on a pin 48 secured to the stationary jaw 34 to pivot toward and away from the stationary jaw. The stationary and movable handle members and the elongate tube terminating at a distal end in a jaw tip are structurally similar to conventional grasper and forceps-type microsurgical instruments commonly used for arthroscopic surgery.

In accordance with the present invention, the stationary jaw 34 includes a hollow tip 50, as best shown in Figs. 5 and 6, secured to the distal end of tube 36, the tip being cut away to define a peripheral wall 52 for engaging tissue to be sutured and a recess 54 in which is a secured a hollow, tubular needle 56 having a bevelled cutting tip 58 to penetrate tissue to be sutured. The needle 56 is smoothly curved such that the portion terminating at tip 58 extends substantially transversely from a portion 60 secured in recess 54 and, thus, extends substantially transversely from the plane of the ends of the peripheral wall 52 of the stationary jaw. Pivotal jaw 44 is pivotally mounted to tip 50 on pin 48 and has an inner end 62 attached to rod 42 via pin 46 and an outer end 64 with an aperture 65 therethrough aligned with needle 56 such that needle tip 58 will extend into the aperture when the jaws are closed as shown in Fig. 5. The pivotal jaw 44 has an inner surface 66 facing the surface of peripheral wall 52 of the stationary jaw such that tissue to be sutured can be clamped between surfaces 52 and 66 when the jaws are closed.

A suture feed mechanism 68 is mounted on stationary handle member 24 and includes, as best shown in Fig. 7, mounting plates 70 and 72 having a pair of spaced lower holes to receive screws to secure the plates to opposite sides of the stationary member. Mounting plate 72 has bosses 74 and 76 thereon to define curved upper surfaces 78 forming a recess for receiving a drive roller 80 and curved lower surfaces 82 forming a recess for receiving an idler roller 84. Roller 80 has opposite side flanges 86 forming an central channel receiving a peripheral ring 88 of high friction, autoclavable material, such as silicone rubber, for engaging a suture material 90 that passes between rollers 80 and 84 riding in a peripheral, V-shaped groove 92 in roller 84. Aligned bores 94 and 96 extend through bosses 74 and 76, respectively, to guide suture material 90 therethrough with bore 96 having a countersunk outlet 100 to receive the proximal end 102 of a length of tubing 104 that runs through an opening in the top of hub 30 and through tube 36 below rod 42, as shown in Figs. 2 and 4, to terminate at needle 56. Needle 56 and tubing 104 can be formed of single length of stainless steel tubing or can be two pieces joined at the distal end of the suturing instrument 20. Rollers 80 and 84 are rotatably mounted on pins 106 and 108, respectively, secured in holes in plates 70 and 72.

With the exception of ring 88, all components

of the suturing instrument 20 are preferably constructed of stainless steel; and, with the ring made of silicone rubber, the entire instrument is autoclavable.

The jaws of the suturing instrument can extend from the distal end of the tube 36 in alignment with the longitudinal axis thereof, as described above and shown at 110 in Fig. 9, or can be bent to the right or left, as shown in Figs. 8 and 10, at 112 and 114, respectively, to extend at an angle to the longitudinal axis of tube 36. The pivot pins 46 and 48 are positioned at the same place in the straight, right hand and left hand configurations with the stationary and pivotal jaws bent beyond pivot pin 48. Aperture 65 in the pivotal jaws are oblong to facilitate accommodation of the needle 56 when the jaws are closed clamping tissue to be sutured therebetween. While an aperture is preferred to increase structural integrity of the pivotal jaw, an opening of any shape, such as a slot, can be used.

Use and operation of the suturing instrument will be described with reference to Figs. 11 - 16. The suturing instrument 20 is inserted into the body through an incision or portal 116 in the skin and moved to the tissue to be sutured 118. In most cases, the suturing instrument will be inserted through a tube or cannula 120, and positioning of the suturing instrument is accomplished using conventional arthroscopic instruments which permit television viewing of the surgical site for inspection, diagnosis and surgery. The jaws are opened by pivoting movable handle member 26 away from stationary handle member 24 using the finger and thumb, respectively, to cause pivotal jaw 44 to pivot away from stationary jaw 34 due to movement of rod 42, as shown in Figs. 2 and 6 and in dashed lines in Fig. 11. When the jaws are properly positioned on opposite sides of tissue 118 to be sutured, the movable handle member 26 is moved toward the stationary handle member 24 by squeezing the finger and thumb together causing the tissue engaging surfaces 52 and 66 of the jaws to clamp the tissue while needle 56 is forced through the tissue and into opening 65 in pivotal jaw 44. Accordingly, the suture instrument operates as a punch as needle 56 penetrates through the tissue.

After the jaws are operated to punch needle 56 through the tissue 118, suture material 90 is forced through the needle to exit from the open tip of the needle and pass through the opening 65 in pivotal jaw 44, as shown in Fig. 12. To accomplish this, the suture material is fed through inlet 98 of the suture feed mechanism, and the drive roller 80 is rotated clockwise, looking at Fig. 3, with a finger or thumb. The ring 88 engages the suture material which rides in the groove 92 in idler roller 84, and the rollers cooperate to grip and move the suture material. In this manner, the suture material is fed through outlet 100 of the suture feed mechanism and through tubing 104 and needle 56. In practice, the suture material will be fed through the needle and backed off to be adjacent to the needle tip but within the needle prior to insertion of the suturing instrument into the portal 116 such that minimal rotation of drive roller 80 is required to cause a length of the suture material to extend out of needle 56, as shown in Fig. 12.

Once a sufficient length of the suture material is fed through as shown in Fig. 12, the jaws are opened to withdraw the needle back through the tissue; and, the suturing instrument 20 is moved away from the tissue 118 causing a free end segment 122 of the suture material to be folded back on itself, the edge of the aperture 65 in the pivotal jaw 44 catching the suture material to pull the free end segment of the suture material out while the suture material is also fed toward the jaws by driver roller 80 such that the suturing instrument can be withdrawn from the body leaving the suture in place through the tissue as shown in Fig. 14.

With the ends of the suture outside the body, a knot 124 can be tied by the surgeon in any conventional fashion, as shown in Fig. 15; and, the knot can be pushed through the cannula 120 using a throw stick 126 to a position adjacent the tissue 118, as shown in Fig. 16. The knot can now be tightened by pulling on either or both ends of the suture material. Several knots may be tied, and the suture material is then cut with the use of a microsurgical scissors allowing the cut ends of the suture material to be withdrawn through the tube 120.

As will be appreciated from the above, the suturing instrument of the present invention operates as a punch to allow feeding of suture material through tissue to be sutured within the body, knotting the suture material externally of the body and placing and tightening the knot adjacent the tissue without requiring open surgery thereby permitting repair of ligaments and meniscus, among other tissues, arthroscopically.

It permits suturing during surgery with an instrument which can be introduced through an arthroscopic tube or cannula to to set a suture in tissue and withdrawn to permit tying a knot and tightening of the knot adjacent the tissue. The instrument may be manipulated by a surgeon in a manner similar to a conventional grasper or forceps, and suture material can be fed through a hollow needle after the needle has been forced through tissue to be sutured allowing the suture material to be pulled from the body, a knot tied therein and the knot moved back into the body adjacent the tissue.

The suturing can be accomplished without requiring open surgery, the suturing instrument is simple in structure facilitating its use in surgery,

and the suturing instrument permits accurate placement of sutures by the jaws clamping tissue to be sutured while the hollow needle penetrates the tissue.

Claims

1. A suturing instrument for use in arthroscopic surgery characterised by including,
a stationary member including an elongated tube (36) having a proximal end and a distal end and a stationary handle member (24) extending from said proximal end of said tube (36) and grippable by a user,
a movable handle member (26) mounted on said stationary member and grippable by a user so as to moved towards and away from said stationary handle member (24),
jaw means (34, 44) disposed at said distal end of said tube (36) for clamping and penetrating tissue to be sutured including a first jaw (34) having a hollow needle (56) extending therefrom, a second jaw (44) having an opening (65) therein, and means mounting said first and second jaw (34, 44) to permit relative movement of said jaws (34, 44) towards and away from each other to define closed and open positions, respectively, said needle (56) extending into said opening (65) in said second jaw (44) when said jaw means is in said closed position,
connector means connecting said movable handle member (26) with said jaw means (34, 44) to cause relative movement of said first and second jaws (34, 44) as said movable member (26) is moved towards and away from said stationary handle member (24),and
suture material feeding means for feeding suture material (90) along said tube (36) to said needle (56) and, with said jaw means (34, 44) in said closed position, through said needle (56) and said opening (65) in said second jaw (44) whereby suture material can be passed through tissue to be sutured when said jaw means in in said closed position, and, thereafter, when said jaw means is in said open position, the suture material can be drawn away from the tissue to be sutured.

2. A suturing instrument as claimed in Claim 1, wherein said suture material feeding means (68) includes a roller feed mechanism (80, 84) mounted on said stationary member having an inlet for receiving suture material, an outlet (100) for exit of suture material and roller means (80,84) rotatable to feed suture material from said inlet to said outlet, and tubing means (104) connected with said outlet (100) of said roller feed mechanism and said hollow needle (56) for passage therethrough of suture material.

3. A suturing instrument as claimed in Claim 2, wherein said roller means (80,84) includes a drive roller (80) having peripheral surface and an idler roller (84) having a peripheral surface adjacent said peripheral surface of said drive roller (80), suture material passing between said drive and idler rollers to be engaged and driven by said peripheral surface of said drive roller (80).

4. A suturing instrument as claimed in Claim 3, wherein said drive roller (80) has a ring (88) of silicone rubber around said peripheral surface to engage suture material.

5. A suturing instrument as claimed in Claim 4, wherein said idler roller (84) has a groove (92) in said peripheral surface to receive suture material.

6. A suturing instrument as claimed in Claim 1, wherein said first jaw (34) extends from said distal end of said tube (36) and has a tissue engaging surface, said second jaw (44) has a tissue engaging surface facing said tissue engaging surface of said first jaw (34), and said mounting means includes means for mounting said second jaw (44) for pivotal movement relative to said first jaw (34).

7. A suturing instrument as claimed in Claim 6, wherein said opening (65) in said second jaw (44) is an aperture having an edge for engaging suture material passing therethrough when said suturing instrument is move away from the tissue to be sutured.

8. A suturing instrument as claimed in Claim 1, wherein said stationary member includes a hub (30) disposed between said proximal end of said tube (36) and said stationary handle member (24), said movable handle member (26) is pivotally mounted on said stationary member at said hub (30), and, said movable and stationary handle members (26, 24) extend from said hub (30) substantially at angles to the longitudinal axis of said tube (36).

9. A suturing instrument as claimed in Claim 1, wherein said suture material feeding means (68) includes a rollerfeed mechanism (80, 84) mounted on said stationary handle member and having a drive roller (80) and an idler roller (84) for feeding suture material, a hub (30) has an opening therein, and a length of metal tubing (104) extends from said hub opening through said elongated tube (36) and is curved at said first jaw (34) to terminate at a beveled end defining a tip for said hollow needle (56) to supply suture material fed by said roller feed mechanism to said hollow needle (56).

10. A suturing instrument for use in surgery characterised by including,
a member including an elongated tube (36) having a proximal end and a distal end and a handle member (24) extending from said proximal end of said tube (36) and grippable by a user,
a hollow needle (56) extending from said distal end

of said member for penetrating tissue to be sutured, and

suture material feeding means (68) for feeding suture material along said tube (36) and through said needle (56) whereby suture material can be passed through tissue to be sutured, said suture material feeding means including a roller feed mechanism (80, 84) mounted on said member having inlet means for receiving suture material, outlet means (100) for supplying suture material to said tube and roller means (80,84) rotatable to feed suture material from said inlet means through said outlet means (100) and said tube hollw needle (56) for passage therethrough.

11. A suturing instrument as claimed in Claim 10, including tubing means (104) disposed within said elongate tube (36) and connected with said outlet means (100) and said hollow needle (6) for passage therethrough of suture material.

12. A suturing instrument as claimed in Claim 10, wherein said roller means includes a drive roller (80) having a peripheral surface and an idler roller (84) having a peripheral surface adjacent said peripheral surface of said drive roller (80), suture material passing between said drive and idler rollers (80,84) to be engaged and driven by said peripheral surface of said drive roller (80).

13. A suturing instrument as claimed in Claim 12, wherein said drive roller (80) has a ring (88) of silicone rubber around said peripheral surface to engage suture material and said idler roller (84) has a groove (92) in said peripheral surface to receive suture material.

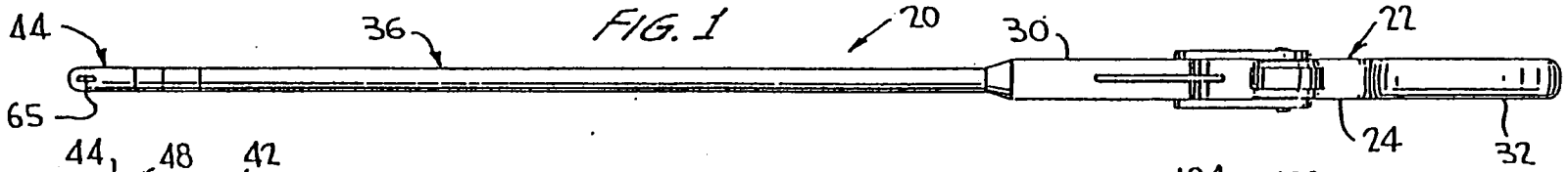


FIG. 1

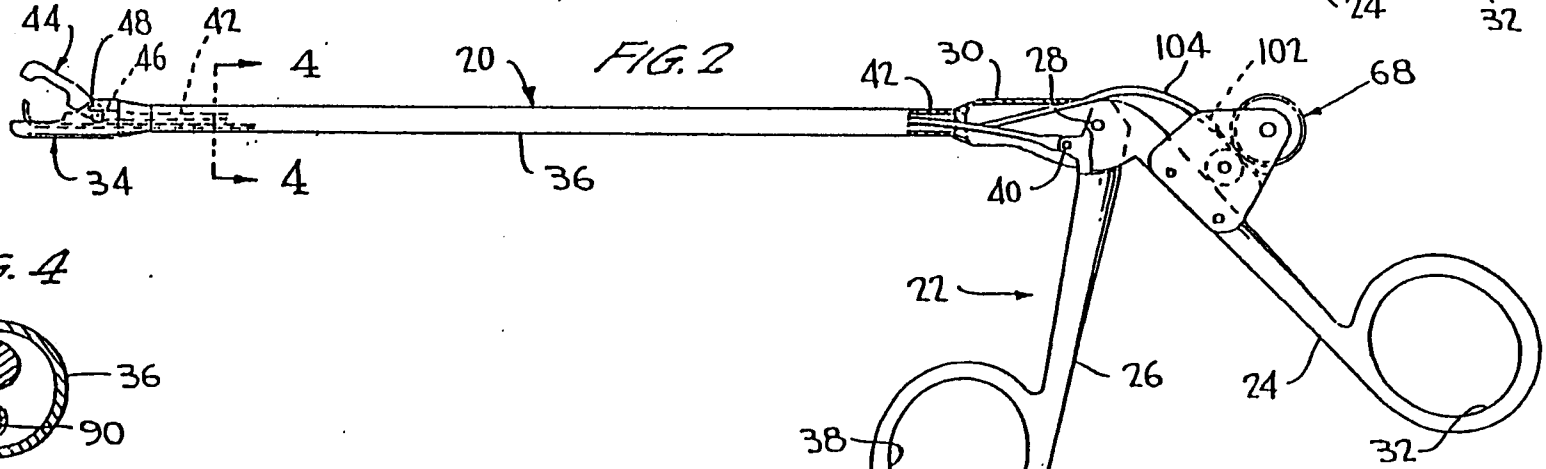


FIG. 2

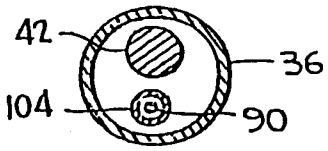


FIG. 4

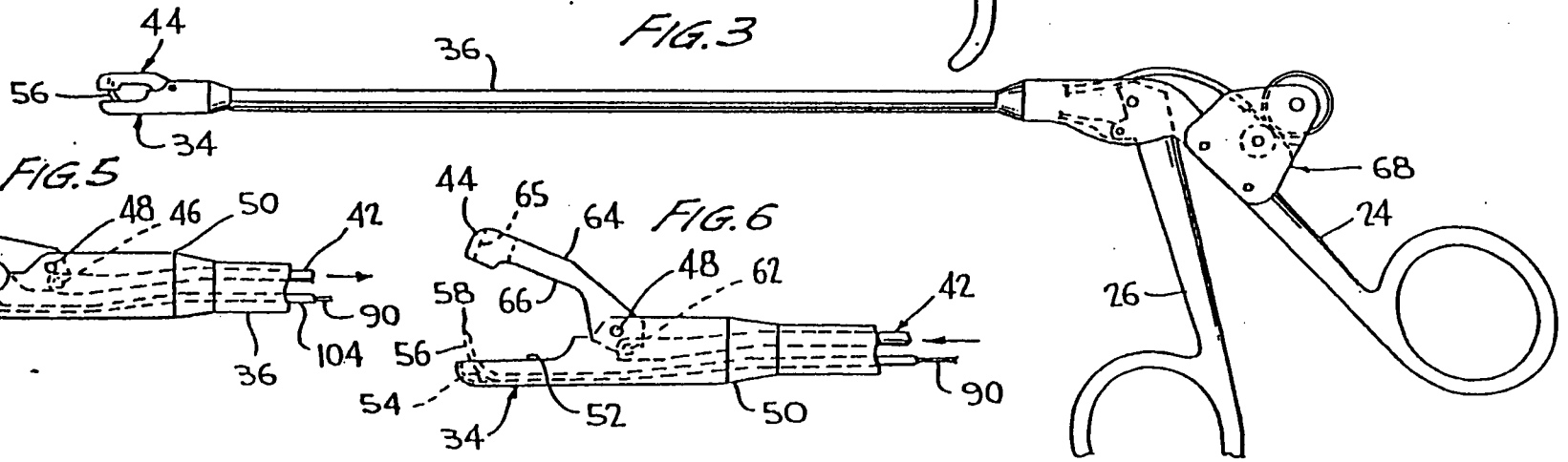


FIG. 3

FIG. 5

FIG. 6

FIG. 7

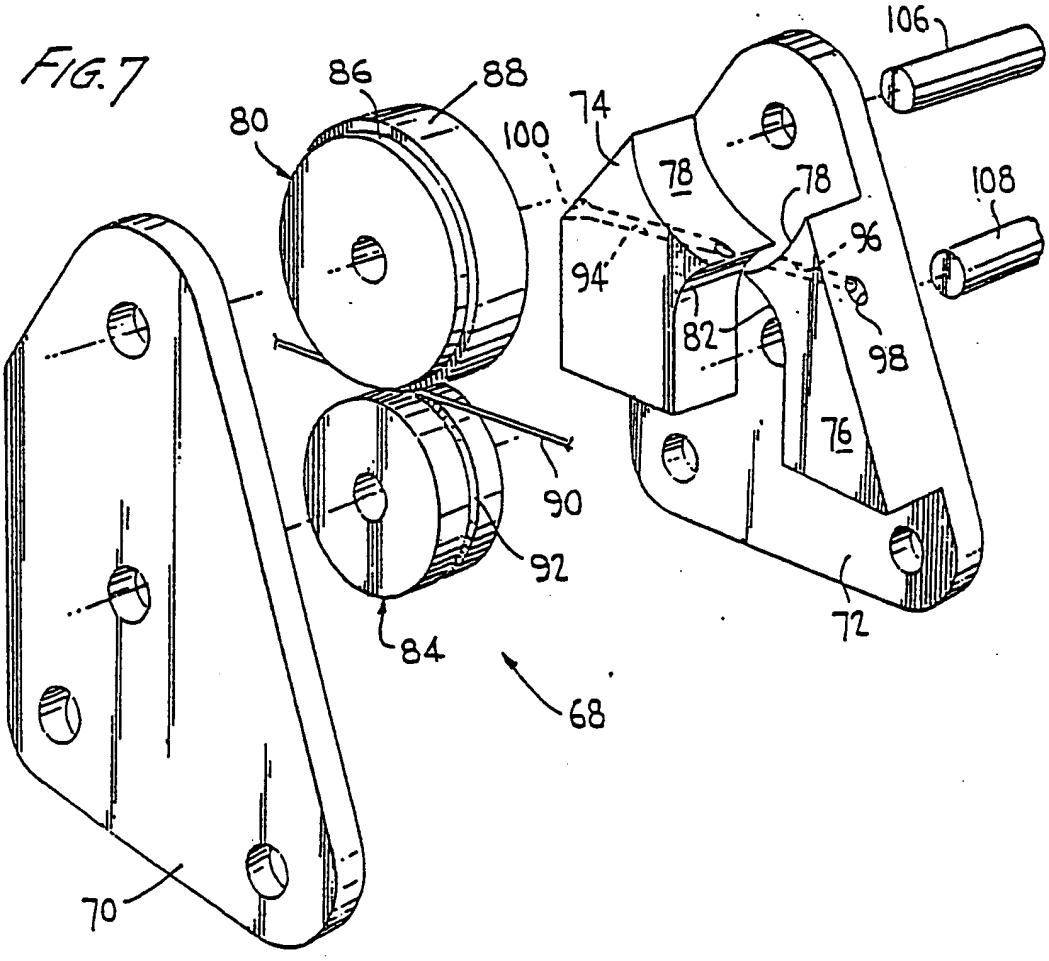


FIG. 8

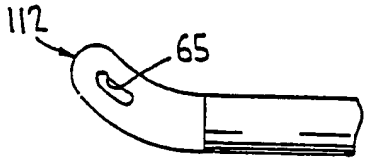


FIG. 9

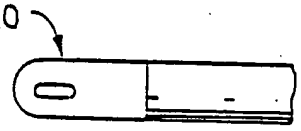


FIG. 10

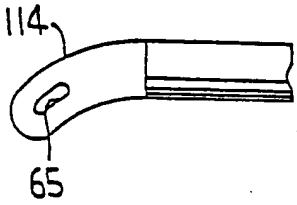


FIG. 11

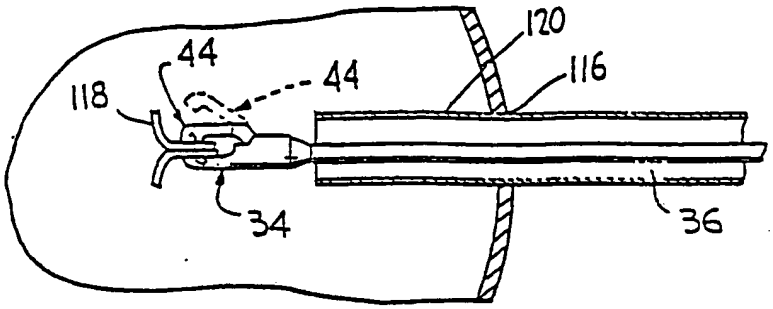


FIG. 12

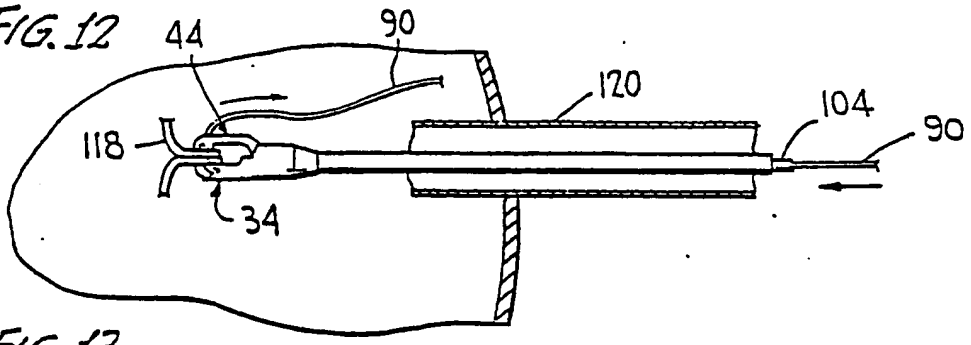


FIG. 13

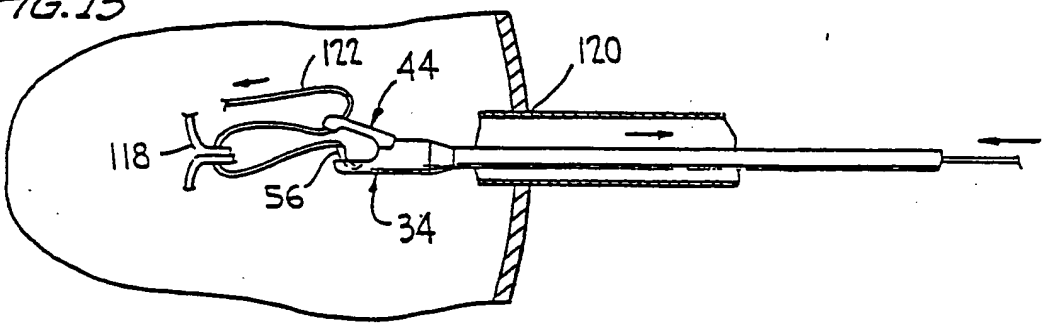


FIG. 14

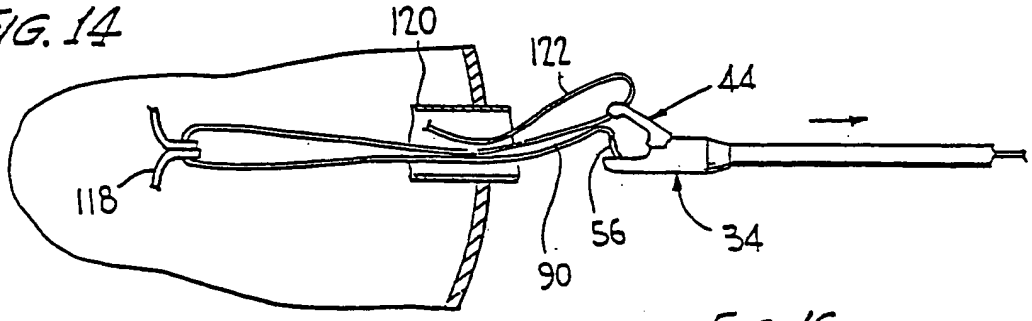


FIG. 15

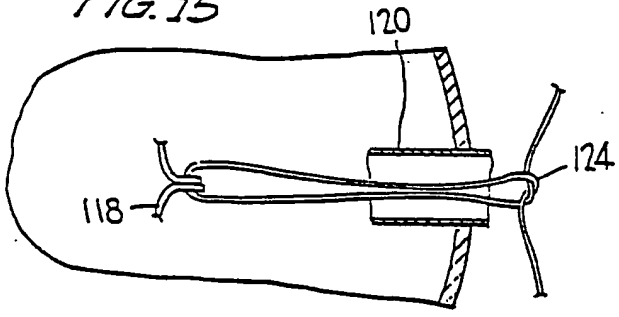


FIG. 16

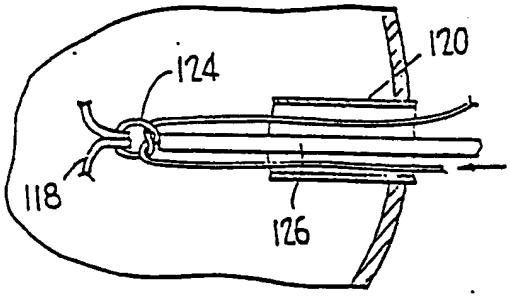


FIG. 11

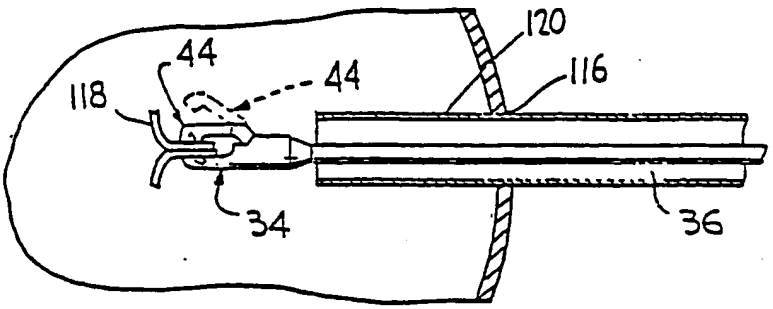


FIG. 12

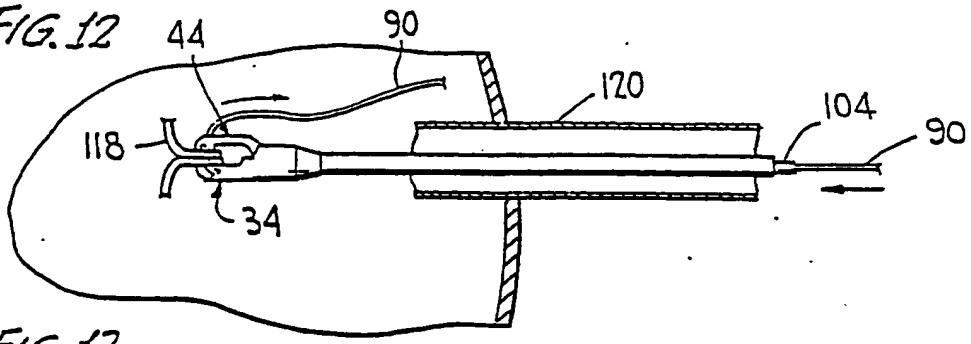


FIG. 13

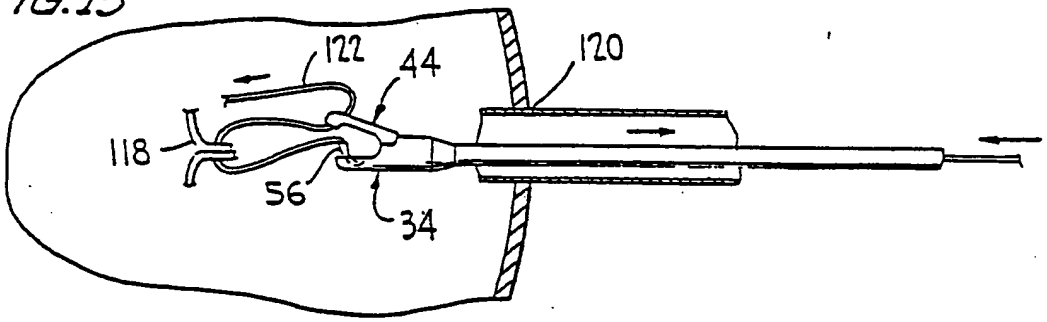


FIG. 14

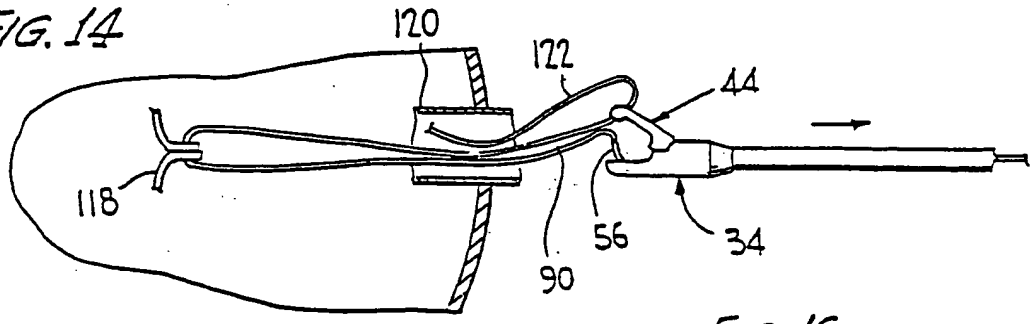


FIG. 15

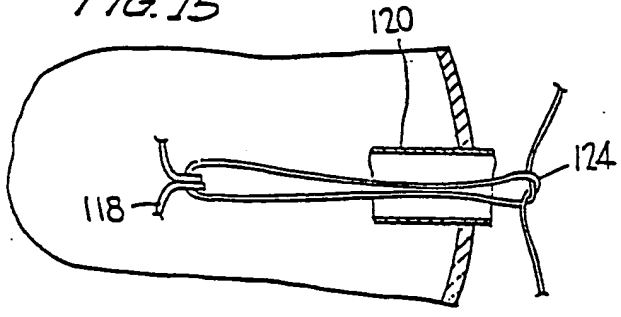
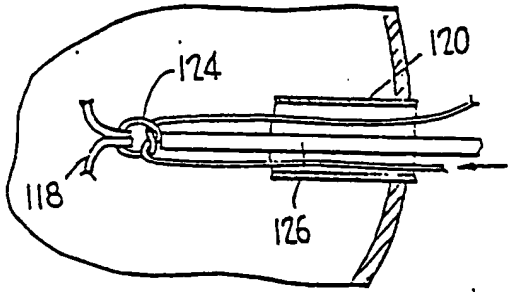


FIG. 16



A suturing instrument for use in arthroscopic surgery

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GB2180455
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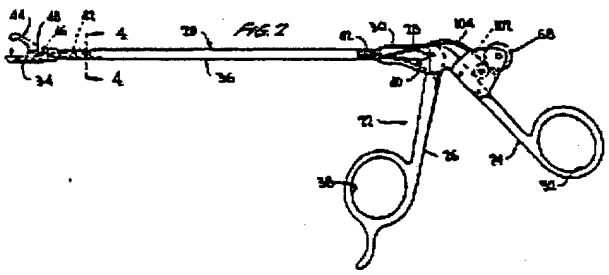
US3090386
FR2573647
US3842840

Abstract of **EP0315371**

A suturing instrument (20) for use in arthroscopic surgery includes a hollow needle (56) for penetrating tissue to be sutured within the body while the tissue is clamped between relatively movable jaws (34, 44), and a suture feed mechanism (68) for feeding suture material (90) through the hollow needle such that the jaws (34,44) can be opened and the suturing instrument withdrawn from the body pulling the free end segment of the suture material (90) with the instrument. A knot can be tied in the suture material (90) externally of the body and the knot moved back into the body at a position adjacent the tissue.



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(54) A suturing instrument for use in arthroscopic surgery.

(57) A suturing instrument (20) for use in arthroscopic surgery includes a hollow needle (56) for penetrating tissue to be sutured within the body while the tissue is clamped between relatively movable jaws (34, 44), and a suture feed mechanism (68) for feeding suture material (90) through the hollow needle such that the jaws (34,44) can be opened and the suturing instrument withdrawn from the body pulling the free end segment of the suture material (90) with the instrument. A knot can be tied in the suture material (90) externally of the body and the knot moved back into the body at a position adjacent the tissue.

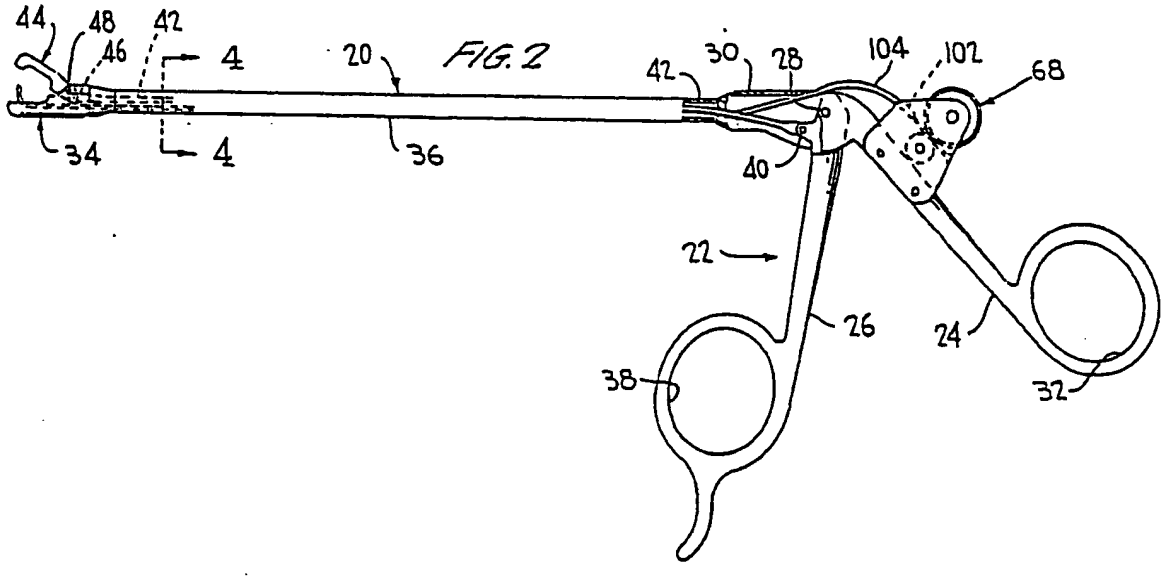

FIG. 2

EP 0 315 371 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 88 31 0121

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	GB-A-2 180 455 (RICHARD WOLF GMBH) * claim 1; figures 1,2 *	1,10	A 61 B 17/10 A 61 B 17/56 A 61 B 17/04
A	US-A-2 959 172 (HELD) * claim 1; figures 2,3 *	1,10	
A	US-A-3 090 386 (CURTIS) * claim 1; figures 1-3 *	1,10	
A	FR-A-2 573 647 (CATIER) * claim 1; page 1, lines 1-12; figure 1 *	1,10	
A	US-A-3 842 840 (SCHWEIZER) * claims 1,3; figures 1-3 *	1,10	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

A 61 B

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
Berlin	12 April 91	PAPA E.R.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same catagory
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention

E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document

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(54) **A suturing instrument for use in arthroscopic surgery.**

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FR-A- 2 573 647
GB-A- 630 693
GB-A- 2 180 455
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US-A- 3 842 840

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EP 0 315 371 B1

Description

This invention pertains to a suturing instrument for use in arthroscopic surgery, such as, for example, for arthroscopic suturing of tissue within the body without requiring open surgery.

Arthroscopic surgery, which is used herein to encompass surgery on various parts of the body requiring only small incisions or portals for insertion of diagnostic and surgical instruments manipulated externally of the body as well as such surgery performed on joints, is preferable over open surgery to avoid the trauma associated with large incisions as well as the hospitalization and prolonged recovery periods required with open surgery and is used whenever possible to achieve the same results as open surgery without the disadvantages thereof. Arthroscopic techniques include internal viewing for diagnosis and identification of problems as well as surgical operations such as meniscus removal or repair, shaving of irregular, roughened patella and other surfaces and articular surface smoothing. While many surgical operations that previously required open surgery can now be performed by arthroscopic surgery, there remain operations that still require open surgery due to the need for direct suturing, such as major ligament repair and cartilage repair.

U. S. Patents No. 4,493,323 to Albright et al, and Nos. 4,602,635 and 4,621,640 to Mulhollan et al are representative of prior art instruments for internal suturing without requiring open surgery; however, such instruments have the disadvantages of requiring multiple instrument manipulation and movement of needles carrying sutures entirely through tissue to be sutured. The instrument of the Albright et al patent includes a pair of needles forced outwardly through the end of a tube by a plunger to penetrate and extend through the tissue to be sutured and through the skin to permit the needles to be grasped by the surgeon and pulled to position a suture thread loop attached to the needles. The instrument of the Mulhollan et al patent 4,621,640 includes a curved needle carried by a pivotal head movable to cause the needle to be set in the tissue to be sutured, the needle then being realised and the instrument withdrawn to allow insertion of another instrument to pull the needle through. The Mulhollan et al patent, 4,602,635 relates to an instrument for tying knots in sutures in a manipulation area external of the body after the sutures are sewn through the tissue and then pushing the knots into place adjacent the tissue.

U. S. Patents No. 919,138 to Drake et al, No. 3,840,017 to Violante, No. 4,224,947 to Fukuda, and No. 4,643,178 to Nastari et al are representative of prior art suturing instruments wherein sutures are passed through hollow needles after the needles penetrate through tissue to be sutured, such suturing instruments having the disadvantage of requiring grasping of the suture material and, thus, being useful only in open surgery and not in arthroscopic surgery.

U. S. Patents No. 1,815,725 to Pilling et al, No. 3,470,875 to Johnson, No. 3,842,840 to Schweizer, No. 3,946,740 to Bassett and No. 4,164,225 to Johnson et al are representative of prior art suturing instruments having pivoted, scissor-like arms with a needle forced through the end of one arm, through tissue to be sutured and into the end of the other arm where the suture is grasped or clamped, such suturing instruments having the disadvantage of being of a structural design to prevent their use in arthroscopic surgery.

U. S. Patent No. 4,312,337 to Donohue discloses an instrument for drilling and wiring bones having scissor-like arms carrying cannula sections through which a wire is passed, the wire being cut and tied after the cannula sections are withdrawn. The scissor-like structure permits this instrument to be used only in open surgery and not in arthroscopic surgery.

Another scissor-like instrument for suturing is disclosed in U. S. Patent No. 4,596,249 to Freda et al, the instrument having a hook passing through tissue to engage a suture and pull it back through the tissue, the instrument not being useful in arthroscopic surgery due to its scissor-like structure.

US patent US-A-2 959 172 describes a suturing instrument for use in surgery, a suturing instrument comprising a member including an elongate tube having a proximal end and a distal end and a handle member extending from said proximal end and grippable by a user, a needle extending from said distal end of said member for penetrating tissue to be sutured, the needle having a notch for receiving suturing material and suture feeding means for feeding suture material to the needle. The suturing instrument is operated using a trigger-like actuating member.

A similar surgical suturing instrument is described in US patent US-A-3 090 386, but is instead provided with a scissor-like actuating member.

French patent application FR-A-2,573,647 describes an instrument for applying a clip to a meniscus by means of an endoscope.

UK patent application GB-A-630,693 describes a thread-feeding surgical needle.

Despite the various instruments already described in the prior art, there remains a need for a generally improved suturing instrument suitable, in particular, for use in arthroscopic surgery.

According to an aspect of the present invention, therefore, there is provided a suturing instru-

ment for use in surgery, said suturing instrument comprising: an elongate tube having a proximal end and a distal end; a handle member extending from said proximal end of said tube and grippable by a user; a needle extending from said distal end of said elongate tube for penetrating tissue to be sutured; and suture material feeding means for feeding suture material along said tube to said needle whereby suture material can be passed through tissue to be sutured, said suture material feeding means including a roller feed mechanism; characterised by: said needle being hollow; a suture material inlet for said roller feed mechanism; a suture material outlet from said roller feed mechanism into said tube; and roller means rotatable to feed suture material from said inlet through said tube to said hollow needle for passage therethrough.

For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a top view of a suturing instrument according to the present invention,

Figures 2 and 3 are side elevations of the suturing instrument of Figure 1 with jaws in open and closed positions, respectively,

Figure 4 is a sectional view taken along line 4-4 of Figure 2,

Figures 5 and 6 are broken side views of the jaws of the suturing instrument of Figures 1 to 4 in closed and open positions, respectively,

Figure 7 is an exploded view of a suture feed mechanism of a suturing instrument of Figures 1 to 6,

Figures 8, 9 and 10 are top views of right-hand, straight and left-hand jaw means for the suturing instrument of Figures 1 to 7, and

Figures 11, 12, 13, 14, 15 and 16 illustrate a method of use of the suturing instrument of the present invention.

A suturing instrument 20 according to the present invention is illustrated in Figs. 1, 2 and 3 and included a handle 22 formed of a stationary handle member 24 and a movable handle member 26 pivotally mounted to stationary handle member 24 on a pivot pin 28 secured in a hub 30. The stationary handle member 24 has a thumb ring 32 at one end and forms part of a stationary member including hub 30, a distal stationary jaw 34 and an elongate tube or barrel 36. The movable handle member 26 has a finger ring 38 at one end and extends through an opening in the bottom of the hub to be mounted on pivot pin 28. A flange 40 extends distally from movable handle member 26 and is pivotally attached to a connector rod 42 extending within tube 36 to the distal end thereof where the rod is connected to a pivotal jaw 44 via a pin 46, the jaw 44 being pivotally mounted on a pin 48 secured to the stationary jaw 34 to pivot toward and away from the stationary jaw. The stationary and movable handle members and the elongate tube terminating at a distal end in a jaw tip are structurally similar to conventional grasper and forceps-type microsurgical instruments commonly used for arthroscopic surgery.

In accordance with the present invention, the stationary jaw 34 includes a hollow tip 50, as best shown in Figs. 5 and 6, secured to the distal end of tube 36, the tip being cut away to define a peripheral wall 52 for engaging tissue to be sutured and a recess 54 in which is a secured a hollow, tubular needle 56 having a bevelled cutting tip 58 to penetrate tissue to be sutured. The needle 56 is smoothly curved such that the portion terminating at tip 58 extends substantially transversely from a portion 60 secured in recess 54 and, thus, extends substantially transversely from the plane of the ends of the peripheral wall 52 of the stationary jaw. Pivotal jaw 44 is pivotally mounted to tip 50 on pin 48 and has an inner end 62 attached to rod 42 via pin 46 and an outer end 64 with an aperture 65 therethrough aligned with needle 56 such that needle tip 58 will extend into the aperture when the jaws are closed as shown in Fig. 5. The pivotal jaw 44 has an inner surface 66 facing the surface of peripheral wall 52 of the stationary jaw such that tissue to be sutured can be clamped between surfaces 52 and 66 when the jaws are closed.

A suture feed mechanism 68 is mounted on stationary handle member 24 and includes, as best shown in Fig. 7,mounting plates 70 and 72 having a pair of spaced lower holes to receive screws to secure the plates to opposite sides of the stationary member. Mounting plate 72 has bosses 74 and 76 thereon to define curved upper surfaces 78 forming a recess for receiving a drive roller 80 and curved lower surfaces 82 forming a recess for receiving an idler roller 84. Roller 80 has opposite side flanges 86 forming a central channel receiving a peripheral ring 88 of high friction, autoclavable material, such as silicone rubber, for engaging a suture material 90 that passes between rollers 80 and 84 riding in a peripheral, V-shaped groove 92 in roller 84. Aligned bores 94 and 96 extend through bosses 74 and 76, respectively, to guide suture material 90 therethrough with bore 96 having a countersunk outlet 100 to receive the proximal end 102 of a length of tubing 104 that runs through an opening in the top of hub 30 and through tube 36 below rod 42, as shown in Figs. 2 and 4, to terminate at needle 56. Needle 56 and tubing 104 can be formed of single length of stainless steel tubing or can be two pieces joined at the distal end of the suturing instrument 20. Rollers 80 and 84 are rotatably mounted on pins 106 and 108, respec-

tively, secured in holes in plates 70 and 72.

With the exception of ring 88, all components of the suturing instrument 20 are preferably constructed of stainless steel; and, with the ring made of silicone rubber, the entire instrument is autoclavable.

The jaws of the suturing instrument can extend from the distal end of the tube 36 in alignment with the longitudinal axis thereof, as described above and shown at 110 in Fig. 9, or can be bent to the right or left, as shown in Figs. 8 and 10, at 112 and 114, respectively, to extend at an angle to the longitudinal axis of tube 36. The pivot pins 46 and 48 are positioned at the same place in the straight, right hand and left hand configurations with the stationary and pivotal jaws bent beyond pivot pin 48. Aperture 65 in the pivotal jaws are oblong to facilitate accommodation of the needle 56 when the jaws are closed clamping tissue to be sutured therebetween. While an aperture is preferred to increase structural integrity of the pivotal jaw, an opening of any shape, such as a slot, can be used.

Use and operation of the suturing instrument will be described with reference to Figs. 11 - 16. The suturing instrument 20 is inserted into the body through an incision or portal 116 in the skin and moved to the tissue to be sutured 118. In most cases, the suturing instrument will be inserted through a tube or cannula 120, and positioning of the suturing instrument is accomplished using conventional arthroscopic instruments which permit television viewing of the surgical site for inspection, diagnosis and surgery. The jaws are opened by pivoting movable handle member 26 away from stationary handle member 24 using the finger and thumb, respectively, to cause pivotal jaw 44 to pivot away from stationary jaw 34 due to movement of rod 42, as shown in Figs. 2 and 6 and in dashed lines in Fig. 11. When the jaws are properly positioned on opposite sides of tissue 118 to be sutured, the movable handle member 26 is moved toward the stationary handle member 24 by squeezing the finger and thumb together causing the tissue engaging surfaces 52 and 66 of the jaws to clamp the tissue while needle 56 is forced through the tissue and into opening 65 in pivotal jaw 44. Accordingly, the suture instrument operates as a punch as needle 56 penetrates through the tissue.

After the jaws are operated to punch needle 56 through the tissue 118, suture material 90 is forced through the needle to exit from the open tip of the needle and pass through the opening 65 in pivotal jaw 44, as shown in Fig. 12. To accomplish this, the suture material is fed through inlet 98 of the suture feed mechanism, and the drive roller 80 is rotated clockwise, looking at Fig. 3, with a finger or thumb. The ring 88 engages the suture material which rides in the groove 92 in idler roller 84, and the rollers cooperate to grip and move the suture material. In this manner, the suture material is fed through outlet 100 of the suture feed mechanism and through tubing 104 and needle 56. In practice, the suture material will be fed through the needle and backed off to be adjacent to the needle tip but within the needle prior to insertion of the suturing instrument into the portal 116 such that minimal rotation of drive roller 80 is required to cause a length of the suture material to extend out of needle 56, as shown in Fig. 12.

Once a sufficient length of the suture material is fed through as shown in Fig. 12, the jaws are opened to withdraw the needle back through the tissue; and, the suturing instrument 20 is moved away from the tissue 118 causing a free end segment 122 of the suture material to be folded back on itself, the edge of the aperture 65 in the pivotal jaw 44 catching the suture material to pull the free end segment of the suture material out while the suture material is also fed toward the jaws by driver roller 80 such that the suturing instrument can be withdrawn from the body leaving the suture in place through the tissue as shown in Fig. 14.

With the ends of the suture outside the body, a knot 124 can be tied by the surgeon in any conventional fashion, as shown in Figure 15; and, the knot can be pushed through the cannula 120 using a throw stick 126 to a position adjacent the tissue 118, as shown in Figure 16. The knot can be tightened by pulling on either or both ends of the suture material. Several knots may be tied, and the suture material is then cut with the use of a microsurgical scissors allowing the cut ends of the suture material to be withdrawn through the tube 120.

As will be appreciated from the above, the described embodiments of a suturing instrument in accordance with the invention operates as a punch to allow feeding of suture material through tissue to be sutured within the body, knotting the suture material externally of the body and placing and tightening the knot adjacent the tissue without requiring open surgery thereby permitting repair of ligaments and meniscus, among other tissues, arthroscopically.

It permits suturing during surgery with an instrument which can be introduced through an arthroscopic tube or cannula to set a suture in tissue and withdrawn to permit tying a knot and tightening of the knot adjacent the tissue. The instrument may be manipulated by a surgeon in a manner similar to a conventional grasper or forceps, and suture material can be fed through a hollow needle after the needle has been forced through tissue to be sutured allowing the suture material to be pulled from the body, a knot tied therein and the knot moved back into the body adjacent the tissue.

Thus suturing can be accomplished without requiring open surgery, the suturing instrument is simple in structure facilitating its use in surgery, and the suturing instrument permits accurate placement of sutures by the jaws clamping tissue to be sutured while the hollow needle penetrates the tissue.

Claims

1. A suturing instrument for use in surgery, said suturing instrument comprising:
an elongate tube (36) having a proximal end and a distal end;
a handle member (24) extending from said proximal end of said tube (36) and grippable by a user;
a needle (56) extending from said distal end of said elongate tube for penetrating tissue to be sutured; and
suture material feeding means (68) for feeding suture material along said tube (36) to said needle (56) whereby suture material can be passed through tissue to be sutured, said suture material feeding means including a roller feed mechanism (80, 84);
characterised by:
said needle (56) being hollow;
a suture material inlet for said roller feed mechanism;
a suture material outlet from said roller feed mechanism into said tube; and
roller means (80, 84) rotatable to feed suture material from said inlet through said tube to said hollow needle (56) for passage therethrough.

2. A suturing instrument according to claim 1, wherein said outlet comprises tubing means (104) disposed within said elongate tube (36) connected between said roller feed mechanism (80, 84) and
said hollow needle (6) for passage therethrough of suture material.

3. A suturing instrument according to claim 2, wherein said roller means includes a drive roller (80) having a peripheral surface and an idler roller (84) having a peripheral surface adjacent said peripheral surface of said drive roller (80), suture material passing between said drive and idler rollers (80, 84) to be engaged and driven by said peripheral surface of said drive roller (80).

4. A suturing instrument according to claim 3, wherein said drive roller (80) has a ring (88) of silicone rubber around said peripheral surface to engage suture material and said idler roller (84) has a groove (92) in said peripheral surface to receive suture material.

5. A suturing instrument according to any one of the preceding claims comprising:
a stationary member including said elongated tube (36) and said handle member, which forms a stationary handle member (24);
a movable handle member (26) mounted on said stationary member and grippable by a user so as to move towards and away from said stationary handle member (24);
jaw means (34, 44) disposed at said distal end of said tube (36) for clamping and penetrating tissue to be sutured including a first jaw (34) having said hollow needle (56) extending therefrom, a second jaw (44) having an opening (65) therein, and means mounting said first and second jaw (34, 44) to permit relative movement of said jaws (34, 44) towards and away from each other to define closed and open positions, respectively, said needle (56) extending into said opening (65) in said second jaw (44) when said jaw means is in said closed position; and
connector means connecting said movable handle member (26) with said jaw means (34, 44) to cause relative movement of said first and second jaws (34, 44) as said movable member (26) is moved towards and away from said stationary handle member (24);
wherein said suture material feeding means feeds suture material (90) through said tube (36) to said needle (56) and, with said jaw means (34, 44) in said closed position, through said needle (56) and said opening (65) in said second jaw (44) whereby suture material can be passed through tissue to be sutured when said jaw means is in said closed position and, thereafter, when said jaw means is in said open position, the suture material can be drawn away from the tissue to be sutured.

6. A suturing instrument as claimed in claim 5, wherein said first jaw (34) extends from said distal end of said tube (36) and has a tissue engaging surface, said second jaw (44) has a tissue engaging surface facing said tissue engaging surface of said first jaw (34), and said mounting means includes means for mounting said second jaw (44) for pivotal movement relative to said first jaw (34).

7. A suturing instrument as claimed in claim 6, wherein said opening (65) in said second jaw (44) is an aperture having an edge for engaging suture material passing therethrough when

said suturing instrument is moved away from the tissue to be sutured.

8. A suturing instrument as claimed in any one of claims 5 to 7, wherein said stationary member includes a hub (30) disposed between said proximal end of said tube (36) and said stationary handle member (24), said movable handle member (26) is pivotally mounted on said stationary member at said hub (30), and said movable and stationary handle members (26, 24) extend from said hub (30) substantially at angles to the longitudinal axis of said tube (36).

9. A suturing instrument as claimed in any one of claims 5 to 8, wherein said suture material feeding means (68) includes a roller feed mechanism (80, 84) mounted on said stationary handle member and having a drive roller (80) and an idler roller (84) for feeding suture material, a hub (30) has an opening therein, and a length of metal tubing (104) extends from said hub opening through said elongate tube (36) and is curved at said first jaw (34) to terminate at a bevelled end defining a tip for said hollow needle (56) to supply suture material fed by said roller feed mechanism to said hollow needle (56).

Patentansprüche

1. Nähgerät für die Verwendung in der Chirurgie mit:
einem länglichen Rohr (36) mit einem proximalen Ende und einem distalen Ende,
einem Handgriffteil (24), das sich von dem proximalen Ende des Rohres (36) aus erstreckt und von einem Verwender ergreifbar ist,
einer Nadel (56), die sich von dem distalen Ende des länglichen Rohres aus erstreckt, um in ein zu nähendes Gewebe einzudringen, und
einer Nähmaterialzuführeinrichtung (68) zum Zuführen von Nähmaterial entlang dem Rohr (36) zu der Nadel (56), wodurch Nähmaterial durch zu nähendes Gewebe geführt werden kann, wobei diese Nähmaterialzuführeinrichtung einen Rollenzuführmechanismus (80, 84) einschließt,
gekennzeichnet durch:
die Tatsache, daß die Nadel (56) hohl ist,
einen Nähmaterialeinlaß für den Rollenzuführmechanismus,
einen Nähmaterialauslaß aus dem Rollenzuführmechanismus in das Rohr und
einen drehbaren Rollenmechanismus (80,84), um Nähmaterial von dem Einlaß durch das Rohr zu der hohlen Nadel (56) für einen Durchgang durch diese zu führen.

2. Nähgerät nach Anspruch 1, bei dem der Auslaß eine in dem länglichen Rohr (36) angeordnete Röhreneinrichtung (104) umfaßt, die eine Verbindung zwischen dem Rollenzuführmechanismus (80, 84) und der hohlen Nadel (6) für den Durchgang von Nähmaterial durch sie schafft.

3. Nähgerät nach Anspruch 2, bei dem die Rolleneinrichtung eine Antriebsrolle (80) mit einer Umfangsoberfläche und eine Mitläuferrolle (84) mit einer Umfangsoberfläche in Nachbarschaft zu der Umfangsoberfläche der Antriebsrolle (80) einschließt, wobei Nähmaterial zwischen der Antriebsrolle und der Mitläuferrolle (80, 84) hindurchgeht, um an der Umfangsoberfläche der Antriebsrolle (80) anzuliegen und von ihr angetrieben zu werden.

4. Nähgerät nach Anspruch 3, bei dem die Antriebsrolle (80) einen Ring (88) von Silikonkautschuk um die Umfangsoberfläche hat, um an dem Nähmaterial anzuliegen, und die Mitläuferrolle (84) eine Nut (92) in der Umfangsoberfläche hat, um Nähmaterial aufzunehmen.

5. Nähgerät nach einem der vorausgehenden Ansprüche mit
einem ortsfesten Teil, welches das längliche Rohr (36) und das Handgriffteil einschließt, welches ein ortsfestes Handgriffteile (24) bildet
einem beweglichen Handgriffteil (26), das an dem ortsfesten Teil befestigt ist und von einem Verwender so ergreifbar ist, daß es sich zu dem ortsfesten Teil (24) hin und von ihm weg bewegt,
Klemmbackeneinrichtungen (34, 44), die an dem distalen Ende des Rohres (36) zum Festklemmen und Durchdringen von zu nähendem Gewebe angeordnet sind, mit einer ersten Klemmbacke (34) mit der sich von ihr aus erstreckenden hohlen Nadel (56) einer zweiten Klemmbacke (44) mit eienr Öffnung (65) darin und einer Einrichtung, die die erste und zweite Klemmbacke (34, 44) so befestigt, daß sie eine Relativbewegung der Klemmbacken (34, 44) zueinander und voneinander erlaubt, um eine geschlossene bzw. offene Position zu definieren, wobei sich die Nadel (56) in die Öffnung (65) in der zweiten Klemmbacke (44) erstreckt, wenn diese Klemmbackeneinrichtung sich in der geschlossenen Position befindet und
einer Verbindungseinrichtung, die das bewegliche Handgriffteil (26) mit den Klemmbackeneinrichtungen (34, 44) verbindet, um eine Relativbewegung der ersten und zweiten Klemm-

backe (34, 44) zu bewirken, wenn das bewegliche Teil (26) zu dem ortsfesten Handgriffteil (24) und von diesem weg bewegt wird,
wobei die Nähmaterialzuführeinrichtung Nähmaterial (90) durch das Rohr (36) zu der Nadel (56) und mit den Klemmbackenteilen (34, 44) in der geschlossenen Position durch die Nadel (56) und die Öffnung (65) in der zweiten Klemmbacke (44) befördert, wodurch Nähmaterial durch zu nähendes Gewebe gehen kann, wenn die Klemmbackeneinrichtung sich in der geschlossenen Position befindet und danach, wenn die Klemmbackeneinrichtung sich in der offenen Position befindet, das Nähmaterial von dem zu nähenden Gewebe weggezogen werden kann.

6. Nähgerät nach Anspruch 5, bei dem die erste Klemmbacke (34) sich von dem distalen Ende des Rohres (36) aus erstreckt und eine Gewebeeingriffsoberfläche hat, die zweite Klemmbacke (44) eine Gewebeeingriffsoberfläche hat, die zu der Gewebeeingriffsoberfläche der ersten Klemmbacke (34) hin gerichtet ist, und die Befestigungseinrichtung eine Einrichtung zur Befestigung der zweiten Klemmbacke (44) für eine Schwenkbewegung in Bezug auf die erste Klemmbacke (34) einschließt.

7. Nähgerät nach Anspruch 6, bei dem die Öffnung (65) in der zweiten Klemmbacke (44) eine Öffnung mit einer Kante zur Anlage an Nähmaterial ist, welches hindurchgeht, wenn das Nähgerät von dem zu nähenden Gewebe wegbewegt wird.

8. Nähgerät nach einem der Ansprüche 5 - 7, bei dem das ortsfeste Teil eine zwischen dem proximalen Ende des Rohres (36) und dem ortsfesten Handgriffteil (24) angeordnete Buchse (30) einschließt, wobei das bewegliche Handgriffteil (26) schwenkbar an dem ortsfesten Teil an der Buchse (30) befestigt ist, und sich das bewegbare und das ortsfeste Handgriffteil (26, 24) von der Buchse (30) aus im wesentlichen in Winkeln zu der Längsachse des Rohres (36) erstrecken.

9. Nähgerät nach einem der Ansprüche 5 - 8, mit dem die Nähmaterialzuführeinrichtung (68) einen Rollenzuführmechanismus (80, 84) einschließt, der an dem ortsfesten Handgriffteil befestigt ist und eine Antriebsrolle (80) und eine Mitläuferrolle (84) zum Zuführen von Nähmaterial hat, eine Buchse (30) eine Öffnung darin besitzt und eine Metallröhrenlänge (104) sich von der Buchsenöffnung durch das längliche Rohr (36) erstreckt und an der ersten Klemmbacke (34) gekrümmt ist, um an einem eine Spitze für die hohle Nadel (56) definierenden abgefasten Ende zu enden, um von dem Rollenzuführmechanismus der hohlen Nadel (56) zugeführtes Nähmaterial anzuliefern.

Revendications

1. Instrument de suture destiné à la chirurgie, ledit instrument de suture comprenant:
un tube allongé (36) ayant une extrémité proximale et une extrémité distale;
un élément (24) de manette s'étendant de ladite extrémité proximale dudit tube (36) et pouvant être saisi par un utilisateur;
une aiguille (56) s'étendant de ladite extrémité distale dudit tube allongé destinée à pénétrer dans le tissu à suturer; et
un moyen (68) d'alimentation en matériau de suture destiné à alimenter en matériau de suture le long dudit tube (36) ladite aiguille (56) au moyen de laquelle le matériau de suture peut traverser le tissu à suturer, ledit moyen d'alimentation en matériau de suture comprenant un mécanisme (80, 84) d'alimentation à galets;
caractérisé par:
le fait que ladite aiguille (56) est creuse;
une admission de matériau de suture dans ledit mécanisme d'alimentation à galets;
une sortie de matériau de suture dudit mécanisme d'alimentation à galets dans ledit tube; et
un moyen formant galets (80, 84) rotatif pour alimenter en matériau de suture à partir ladite admission en traversant ledit tube ladite aiguille creuse (56) pour traverser celle-ci.

2. Instrument de suture selon la revendication 1, où ladite sortie comprend un moyen (104) formant tuyau disposé dans ledit tube allongé (36) raccordé entre ledit mécanisme (80, 84) d'alimentation à galets et ladite aiguille creuse (6) pour le passage à travers lui du matériau de suture.

3. Instrument de suture selon la revendication 2, où ledit moyen formant galets comprend un galet (80) d'entraînement ayant une surface périphérique et un galet libre (84) ayant une surface périphérique adjacente à ladite surface périphérique dudit galet (80) d'entraînement, le matériau de suture passant entre lesdits galets (80, 84) d'entraînement et libre pour s'engager avec et être entraîné par ladite surface périphérique dudit galet (80) d'entraînement.

4. Instrument de suture selon la revendication 3, où ledit galet (80) d'entraînement comporte une bague (88) de caoutchouc de silicone autour de ladite surface périphérique pour s'engager avec le matériau de suture et ledit galet (84) libre comporte une gorge (92) dans ladite surface périphérique pour recevoir le matériau de suture.

5. Instrument de suture selon une quelconque des revendications précédentes comprenant:

un élément immobile comprenant ledit tube allongé (36) et ledit élément de manette, qui forme un élément immobile (24) de manette;

un élément mobile (26) de manette monté sur ledit élément immobile et pouvant être saisi par un utilisateur de manière à s'approcher et à s'éloigner dudit élément immobile (24) de manette;

un élément (34, 44) formant mâchoires disposé à ladite extrémité distale dudit tube (36) pour pincer et pénétrer dans le tissu à suturer comprenant une première mâchoire (34) comportant ladite aiguille (56) qui s'étend à partir de celle-ci, une seconde mâchoire (44) comportant une ouverture, et un moyen de montage desdites première et seconde mâchoires (34, 44) pour permettre l'éloignement et le rapprochement relatifs desdites mâchoires (34, 44) l'une par rapport à l'autre pour définir des positions fermée et ouverte, respectivement, ladite aiguille (56) s'étendant dans ladite ouverture (65) dans ladite seconde mâchoire (44) lorsque ledit moyen formant mâchoires est dans ladite position fermée; et le moyen de raccordement raccordant ledit élément mobile (26) de manette avec ledit moyen (34, 44) formant mâchoires pour réaliser le mouvement relatif desdites première et seconde mâchoires (34, 44) lorsque ledit élément mobile (26) s'approche et s'éloigne dudit élément immobile (24) de manette;

où ledit moyen d'alimentation en matériau de suture alimente ladite aiguille (56) en matériau (90) de suture à travers ledit tube (36) et, avec ledit moyen (34, 44) formant mâchoires dans ladite position fermée, à travers ladite aiguille (56) et ladite ouverture (65) dans ladite seconde mâchoire (44) grâce à quoi le matériau de suture peut traverser le tissu à suturer lorsque ledit moyen formant mâchoires est dans ladite position fermée et, ensuite, lorsque ledit moyen formant mâchoires est dans ladite position ouverte, le matériau de suture peut être tiré du tissu à suturer.

6. Instrument de suture selon la revendication 5, où ladite première mâchoire (34) s'étend de ladite extrémité distale dudit tube (36) et a une surface s'engageant avec le tissu, ladite seconde mâchoire (44) a une surface s'engageant avec le tissu et faisant face à ladite surface s'engageant avec le tissu de ladite première mâchoire (34), et ledit moyen de montage comprend un moyen pour monter ladite seconde mâchoire (44) pour le mouvement de rotation par rapport à ladite première mâchoire (34).

7. Instrument de suture selon la revendication 6, où ladite ouverture (65) dans ladite seconde mâchoire (44) est une ouverture comportant un bord destiné à s'engager avec le matériau de suture qui la traverse lorsque ledit instrument de suture s'éloigne du tissu à suturer.

8. Instrument de suture selon une quelconque des revendications 5 à 7, où ledit élément immobile comprend un pivot (30) disposé entre ladite extrémité proximale dudit tube (36) et ledit élément immobile (24) de manette, ledit élément mobile (26) de manette est monté de manière à pouvoir pivoter sur ledit élément immobile audit pivot (30), et lesdits éléments (26, 24) mobile et immobile de manette s'étendent dudit pivot (30) en étant sensiblement en biais par rapport à l'axe longitudinal dudit tube (36).

9. Instrument de suture selon une quelconque des revendications 5 à 8, où ledit moyen (68) d'alimentation en matériau de suture comprend un mécanisme (80, 84) d'alimentation à galets monté sur ledit élément immobile de manette et comportant un galet (80) d'entraînement et un galet (84) libre pour l'alimentation en matériau de suture, un pivot (30) comporte une ouverture, et une longueur de tuyau métallique (104) s'étend de ladite ouverture de pivot à travers ledit tube allongé (36) et est incurvée à ladite première mâchoire (34) pour se terminer à une extrémité biseautée définissant une pointe pour ladite aiguille creuse (56) afin d'alimenter ladite aiguille creuse (56) en matériau de suture fourni par ledit mécanisme d'alimentation à galets.

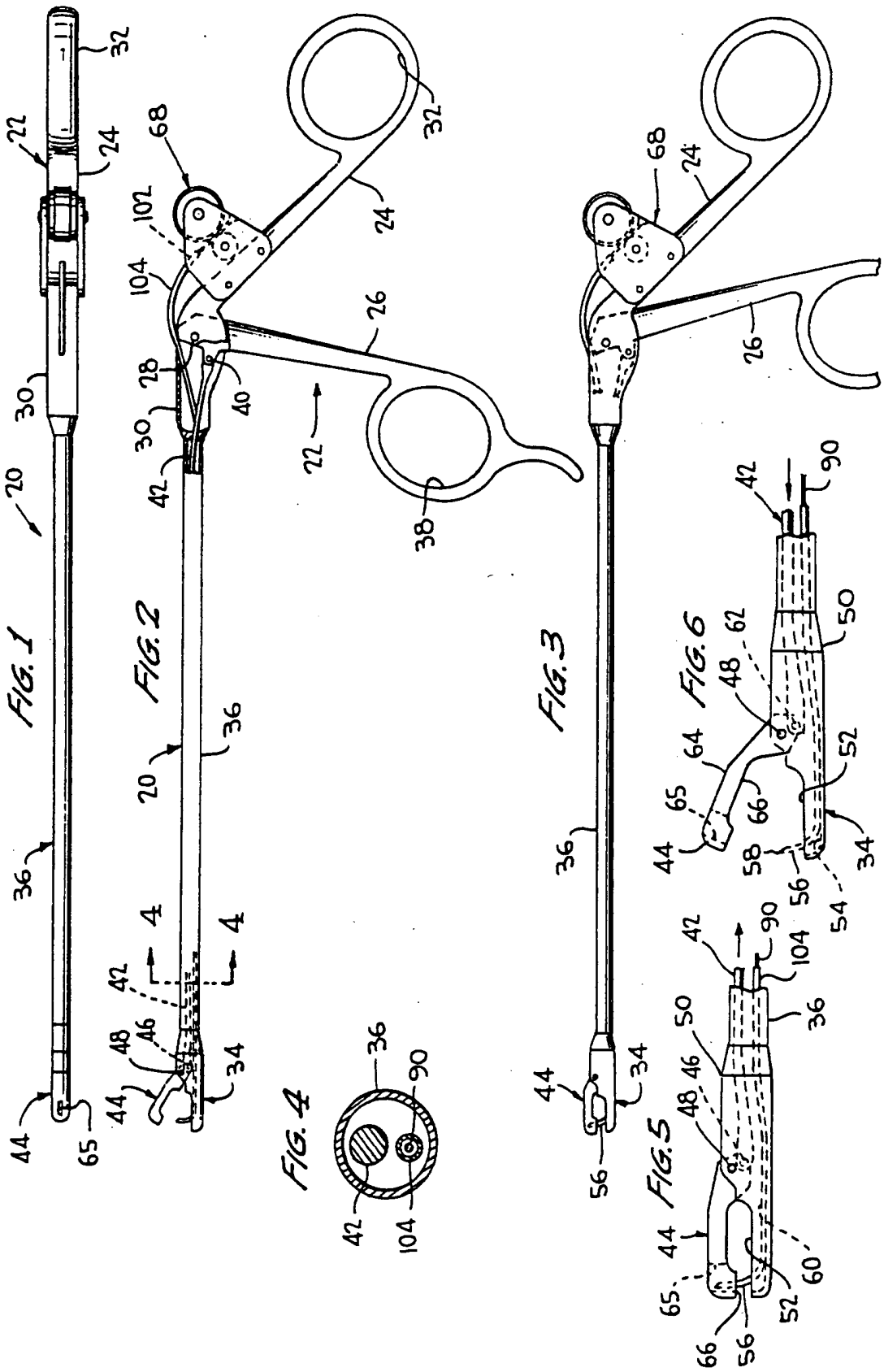
FIG. 1
FIG. 2
FIG. 3
FIG. 4
FIG. 5
FIG. 6

FIG.7

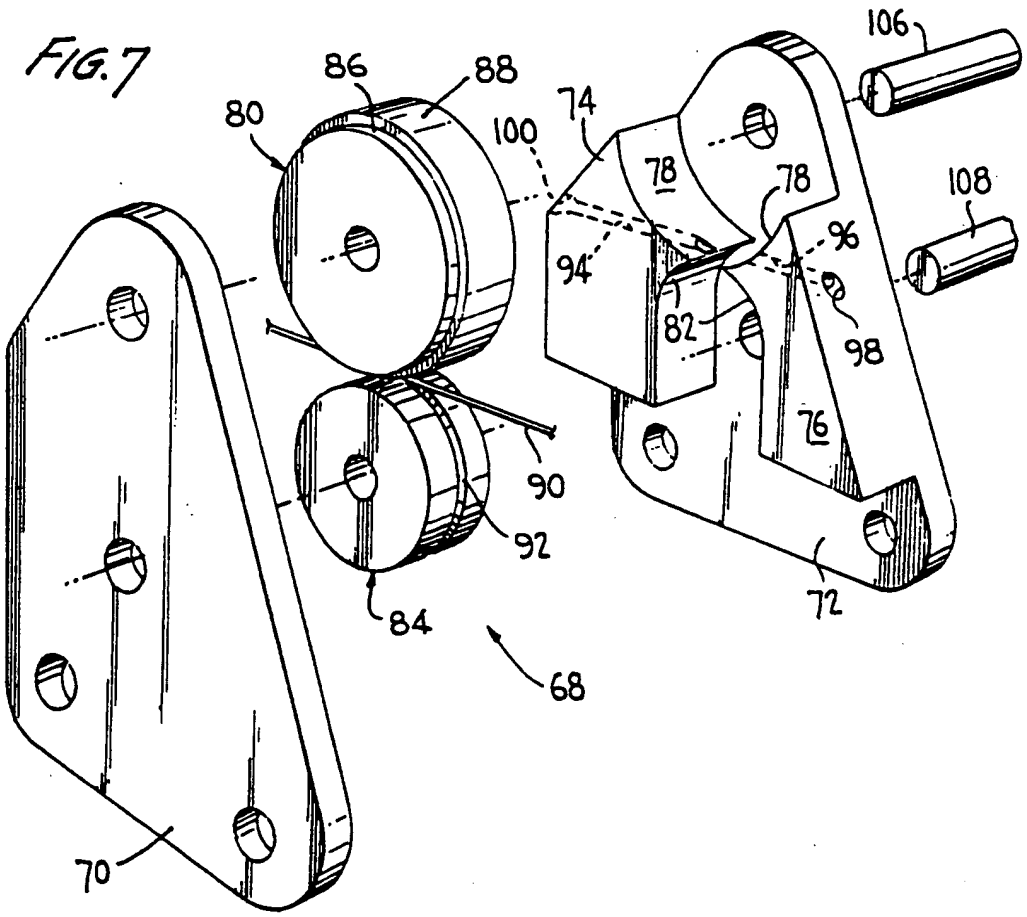

FIG.8

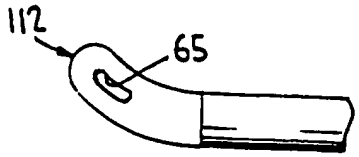

FIG.9

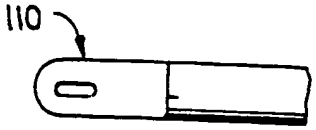

FIG.10

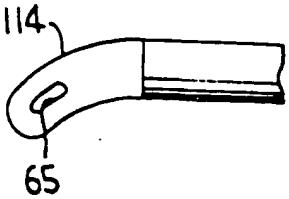

FIG. 11

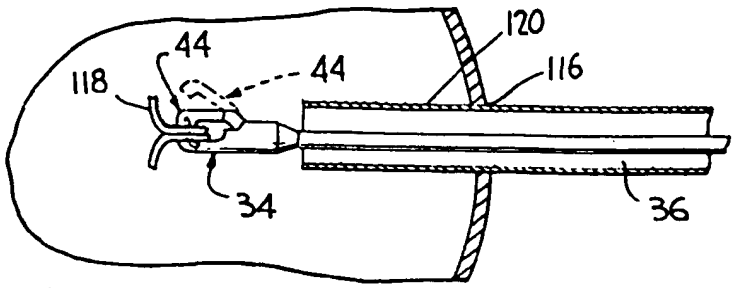

FIG. 12

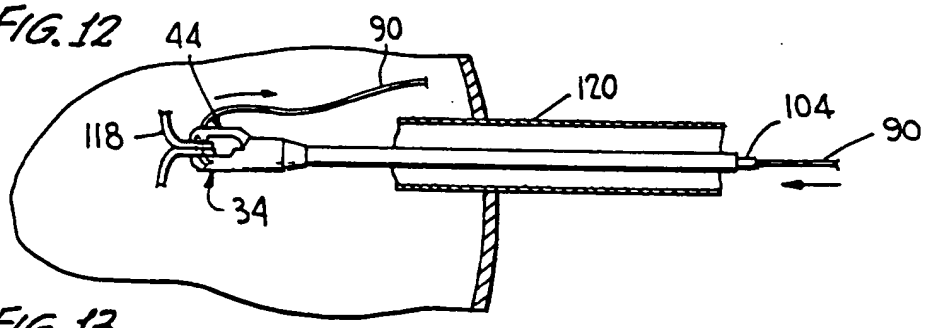

FIG. 13

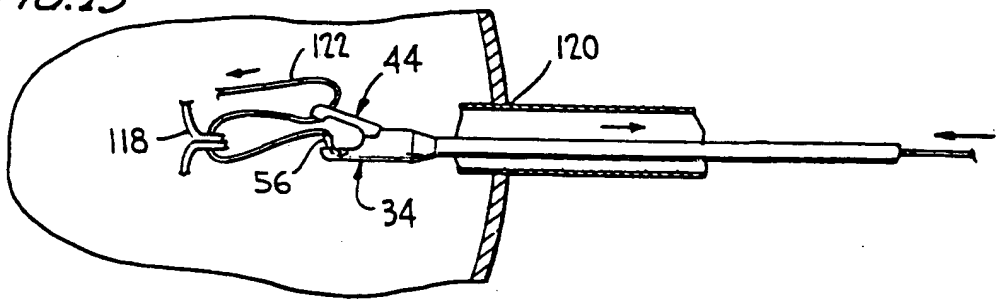

FIG. 14

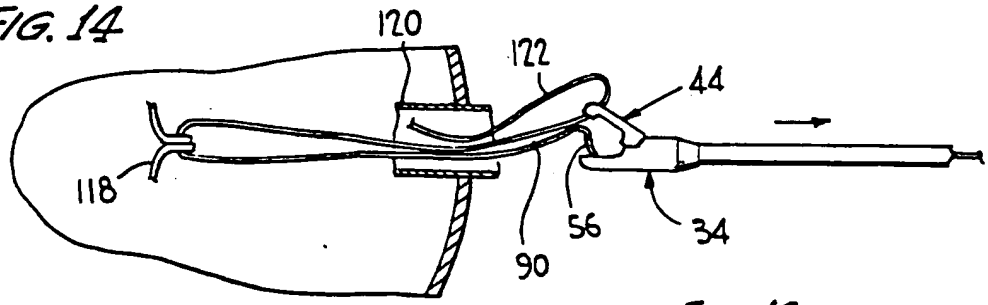

FIG. 15

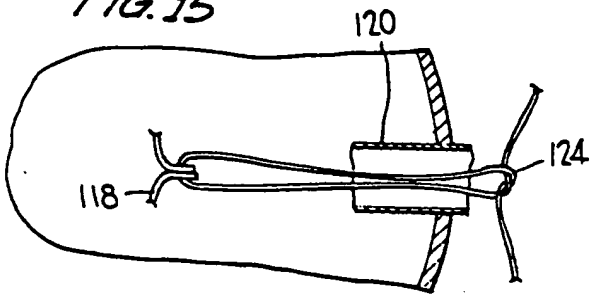

FIG. 16